CLAIMS

What is claimed is:

1. An electric motor comprising:

a support member;

a moving member;

a plurality of electromagnet groups, each group comprising at least one electromagnet set, wherein each electromagnet set comprises a plurality of electromagnet units, wherein each of the electromagnet units comprises at least one coil around a core having two poles, wherein each coil has first and second terminals, wherein the electromagnet units are fixed on the support member and connectable to an energy source, and wherein adjacent electromagnet units are spaced equal distances apart on the support member;

a plurality of permanent magnets, wherein the permanent magnets are supported on the moving member so that during operation of the motor at least some are positioned a magnetically responsive distance from the plurality of electromagnet units on the support member, wherein each of the permanent magnets has a north pole and a south pole, wherein each of the permanent magnets is alternatingly oriented relative to adjacent permanent magnets so that adjacent poles of adjacent permanent magnets have alternating

polarity, and wherein adjacent permanent magnets are spaced equal distances apart on the moving member; and

a drive circuit comprising:

a sequencing circuit having a plurality of sequencing outputs adapted to sequentially activate each of the plurality of electromagnet units in each of the electromagnet sets, whereby the moving member is caused to move relative to the support member;

a power control circuit adapted to control the power generated by the motor by activating selected electromagnet groups, wherein the power control circuit has a plurality of incremental power modes comprising a maximum power mode and at least one nonmaximum power mode, wherein in the maximum power mode all the electromagnet groups are activated, and wherein in the at least one nonmaximum power mode a selected number of the electromagnet groups less than all the groups is activated, the power control circuit comprising:

a power selector having a plurality of power mode outputs corresponding to the maximum power mode and the at least one nonmaximum power mode; and

a cycling circuit having a plurality of cycling outputs adapted to vary which of the plurality of

electromagnet groups are activated by the sequencing circuit when the motor is operating in the at least one nonmaximum power mode without varying the number of groups being activated;

an integration circuit adapted to integrate the sequencing outputs and the cycling outputs to produce a coil control output corresponding to each of the electromagnet units; and

a coil operating circuit adapted to control the activation of each electromagnet unit in response to the coil control output.

2. A vehicle comprising the electric motor of claim 1 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

3. The electric motor of claim 1 wherein the motor further comprises a frame, and wherein the movable member is an endless belt movably supported on the frame.

4. The electric motor of claim 3 wherein each set of electromagnet units comprises four electromagnet units, wherein each of the electromagnet units comprises a pair of coils wound on the same core whereby the poles of the core are reversible by selectively energizing the pair of coils, and wherein the distance between adjacent permanent magnets is twice the distance between adjacent electromagnet units.

5. The electric motor of claim 4 wherein the endless belt is drivingly supported on pair of wheels including a first wheel and a second wheel, wherein the endless belt has an inner surface and an outer surface, wherein permanent magnets are supported on both the inner surface and the outer surface of the endless belt, wherein the frame comprises an operating area including an upper section through which the endless belt passes above and between the pair of wheels and a lower section through which the endless belt passes below and between the pair of wheels, wherein the support member comprises four trays including a first tray in the upper section of the frame above the endless belt, a second tray in the upper section below the endless belt, a third tray in the lower section above the endless belt, and a fourth tray in the lower section below the endless belt, wherein the plurality of electromagnet groups comprises a first, second, third and fourth group, wherein the first group is supported on the first tray, wherein the second group is supported on the second tray, wherein the third group is supported on the third tray, wherein the fourth group is supported on the fourth tray, wherein each electromagnet set in each group comprises four electromagnet units, so that as the endless belt passes through the operating area of the frame activation of the electromagnet units will propel the permanent magnets on the endless belt thereby rotating the first and second wheels.

6. The electric motor of claim 5 wherein the endless belt comprises a central section and first and second lateral sections on the sides of the central section, wherein the central section is adapted to drivingly engage the first and second wheels,

and wherein the first and second lateral sections provide the upper and lower surfaces on which the permanent magnets are supported.

7. The electric motor of claim 1 wherein the distance between adjacent permanent magnets is twice the distance between adjacent electromagnet units.

8. The electric motor of claim 1 wherein the drive circuit comprises a speed control circuit.

9. The electric motor of claim 8 wherein the sequencing circuit comprises a power clock and wherein the speed control circuit comprises means for varying the speed of the pulses emitted from the sequencing circuit power clock.

10. The electric motor of claim 8 wherein the at least one nonmaximum power mode comprises a low power mode, a medium power mode, and a high power mode.

11. The electric motor of claim 10 wherein the power selector comprises a four pole switch comprising a terminal designated for each of the power modes.

12. The electric motor of claim 10 further comprising a direction control circuit adapted to alternate the direction of the sequential activation of the electromagnet units in each set between a forward direction and a reverse direction.

13. The electric motor of claim 12 wherein the direction control circuit comprises a double throw, double pole switch adapted to reverse the order in which the

sequencing circuit activates the plurality of electromagnet units in each of the sets of electromagnet units.

14. The electric motor of claim 1 wherein the plurality of electromagnet groups comprises four groups, wherein each group comprises six electromagnet sets, and wherein each set comprises four electromagnet units, and wherein each unit comprises a pair of double wound coils.

15. The electric motor of claim 1 wherein the plurality of groups of electromagnet sets comprises four groups, wherein each group comprises two electromagnet sets, and wherein each set comprises four electromagnet units, and wherein each unit comprises a pair of double wound coils.

16. The electric motor of claim 1 further comprising a direction control circuit adapted to alternate the direction of the sequential activation of the electromagnet units between a forward direction and a reverse direction.

17. The electric motor of claim 1 further comprising a speed control circuit.

18. A vehicle comprising the electric motor of claim 17 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

19. The electric motor of claim 1 wherein the sequencing circuit comprises:

a power clock connectable to an energy source and adapted to produce energy pulses;

a counter adapted to receive the energy pulses from the power clock and to produce sequential outputs corresponding to a selected one of the electromagnet units in each electromagnet set;

an matrix of OR gates adapted to receive the sequential outputs of the counter and to sustain the pulse from each sequential output for the duration of two clock pulses; and

a time delay circuit adapted to momentarily deactivate each electromagnet unit when it is directly opposite a permanent magnet.

20. The electric motor of claim 19 wherein the power clock in the sequencing circuit is a variable power clock and wherein the electric motor further comprises a speed control circuit comprising means for varying the frequency of the pulses in the variable power clock.

21. A vehicle comprising the electric motor of claim 20 and further comprising a chassis, a wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

22. The electric motor of claim 20 wherein means for varying the frequency of the pulses in the variable power clock comprises a variable resistor.

23. The electric motor of claim 1 wherein the power selector is adapted to produce a power mode output and wherein the cycling circuit comprises:

a power clock connectable to an energy source and adapted to produce energy pulses;

a counter adapted to receive the energy pulses from the fixed power clock and in response thereto to produce sequential on and off output signals corresponding each electromagnet group; and

a matrix of AND gates adapted to integrate the power mode output with the on and off output signals from the counter to produce a cycling output for each electromagnet group.

24. A vehicle comprising the electric motor of claim 23 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

25. The electric motor of claim 23 wherein the power clock is a fixed power clock.

26. The electric motor of claim 23 wherein the integration circuit comprises a matrix of AND gates adapted to receive the cycling outputs of the cycling circuit and the sequencing outputs and to produce in response thereto a coil control output adapted to control the activation of all the electromagnet units.

27. The electric motor of claim 1 further comprising an energy source.

28. The electric motor of claim 1 wherein the energy source comprises a battery.

29. The electric motor of claim 27 wherein the energy source comprises a plurality of batteries including a battery to supply the drive circuit and a battery for each electromagnet unit.

30. The electric motor of claim 27 wherein the energy source comprises a fuel cell.

31. The electric motor of claim 27 wherein the energy source comprises a plurality of fuel cells including a fuel cell to supply the drive circuit and a fuel cell for each coil in each electromagnet unit.

32. The electric motor of claim 1 wherein the support comprises a stator and wherein the moving member comprises a rotor.

33. The electric motor of claim 32 further comprising a frame and wherein the stator is fixed to the frame and the rotor is rotatably supported on the frame.

34. A vehicle comprising the electric motor of claim 33 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

35. The electric motor of claim 33 wherein the permanent magnets on the rotor are supported radially further from the axis of rotation of the rotor than are the electromagnet units on the stator.

36. The electric motor of claim 1 wherein the drive circuit comprises a coil operating circuit for each coil in each electromagnet unit.

37. The electric motor of claim 36 wherein each of the coil operating circuits comprises a MOSFET having an input and first and second outputs, wherein the input is connected to the coil's control output from the integration circuit, wherein the first output is connected to ground, wherein the second output is connected to the first terminal of the coil, and wherein the second terminal of the coil is connectable to an energy source.

38. A vehicle comprising the electric motor of claim 37 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

39. The electric motor of claim 37 wherein each of the electromagnet units comprises a pair of coils double wound on the same core.

40. The electric motor of claim 37 wherein the energy source is a battery.

41. The electric motor of claim 37 wherein the energy source is a fuel cell.

42. The electric motor of claim 36 wherein the coil control outputs of the integration comprise electrical pulses, and wherein the first terminal of each of the coils in an electromagnet unit is connectable to a first energy source and the second

terminal is connected to logic ground, and wherein each of the coil operating circuits comprises:

a leading edge detector having an input and an output, the input connected to the coil control output from the integration circuit;

an SCR connected in series between the first energy source and first terminal of the coil and wherein the gate of the SCR is connected to the output of the leading edge detector;

a trailing edge detector having an input and an output, the input connected to the coil control output from the integration circuit; and

a transistor having a base connected to the output of the trailing edge detector, having a collector connectable to a second energy source, and having an emitter connected to the output of the SCR; and

wherein the first and second energy sources are connectable in series; and

wherein upon detection by the leading edge detector of the leading edge of the pulse from the integration circuit the leading edge detector turns on the SCR energizing the coil, and so that upon detection by the trailing edge detector of the trailing edge of the pulse the trailing edge detector energizes the transistor which turns off the SCR thereby de-energizing the coil.

43. A vehicle comprising the electric motor of claim 42 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

44. The electric motor of claim 42 wherein the first and second energy sources are batteries.

45. The electric motor of claim 42 wherein the first and second energy sources are fuel cells.

46. An electric motor comprising:

a support member;

a moving member;

a plurality of electromagnet groups, each group comprising at least one electromagnet set, wherein each electromagnet set comprises a plurality of electromagnet units, wherein each of the electromagnet units comprises at least one coil around a core having two poles, wherein each coil has first and second terminals, wherein the electromagnet units are fixed on the support member and connectable to a energy source, and wherein adjacent electromagnet units are spaced equal distances apart on the support member, wherein the number of electromagnet units is a factor of 360;

a plurality of permanent magnets, wherein the permanent magnets are supported on the moving member so that during operation of the motor at least some are positioned a magnetically responsive distance from the plurality of electromagnet units on the support member, wherein each of the permanent magnets has a north pole and a south pole, wherein each of the permanent magnets is alternatingly oriented relative to adjacent permanent magnets so that adjacent poles of adjacent permanent magnets have alternating polarity, wherein adjacent permanent magnets are spaced equal

distances apart on the moving member, and wherein the number of permanent magnets is an even number; and

a drive circuit comprising:

a sequencing circuit having a plurality of sequencing outputs adapted to sequentially activate each of the plurality of electromagnet units in each of the sets of electromagnet units, whereby the moving member is caused to move relative to the support member;

a power control circuit adapted to control the power generated by the motor by activating selected electromagnet groups, wherein the power control circuit has a plurality of incremental power modes comprising a maximum power mode and at least one nonmaximum power mode, wherein in the maximum power mode all the electromagnet groups are activated, and wherein in the at least one nonmaximum power mode a selected number of the electromagnet groups less than all the groups is activated, the power control circuit comprising:

a power selector having a plurality of power mode outputs corresponding to the maximum power mode and the at least one nonmaximum power mode; and

a cycling circuit having a plurality of sequential cycling outputs adapted to vary which of the plurality of

electromagnet groups are activated by the sequencing circuit when the motor is operating in the at least one nonmaximum power mode without varying the number of groups being activated;

an integration circuit adapted to integrate the sequencing outputs and the cycling outputs to produce a coil control output corresponding to each of the electromagnet units; and

a coil operating circuit adapted to control the activation of each electromagnet unit in response to the coil control output.

47. A vehicle comprising the electric motor of claim 46 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

48. The electric motor of claim 46 wherein the motor further comprises a frame, and wherein the movable member is an endless belt movably supported on the frame.

49. The electric motor of claim 48 wherein each set of electromagnet units comprises four electromagnet units, wherein each of the electromagnet units comprises a pair of coils wound on the same core whereby the poles of the core are reversible by selectively energizing the pair of coils, and wherein the distance between adjacent permanent magnets is twice the distance between adjacent electromagnet units.

50. The electric motor of claim 49 wherein the endless belt is drivingly supported on pair of wheels including a first wheel and a second wheel, wherein the endless belt has an inner surface and an outer surface, wherein permanent magnets are supported on both the inner surface and the outer surface of the endless belt, wherein the frame comprises an operating area including an upper section through which the endless belt passes above and between the pair of wheels and a lower section through which the endless belt passes below and between the pair of wheels, wherein the support member comprises four trays including a first tray in the upper section of the frame above the endless belt, a second tray in the upper section below the endless belt, a third tray in the lower section above the endless belt, and a fourth tray in the lower section below the endless belt, wherein the plurality of electromagnet groups comprises a first, second, third and fourth group, wherein the first group is supported on the first tray, wherein the second group is supported on the second tray, wherein the third group is supported on the third tray, wherein the fourth group is supported on the fourth tray, wherein each electromagnet set in each group comprises four electromagnet units, so that as the endless belt passes through the operating area of the frame activation of the electromagnet units will propel the permanent magnets on the endless belt thereby rotating the first and second wheels.

51. The electric motor of claim 50 wherein the endless belt comprises a central section and first and second lateral sections on the sides of the central section, wherein the central section is adapted to drivingly engage the first and second wheels,

and wherein the first and second lateral sections provide the upper and lower surfaces on which the permanent magnets are supported.

52. The electric motor of claim 46 wherein the distance between adjacent permanent magnets is twice the distance between adjacent electromagnet units.

53. The electric motor of claim 46 wherein the drive circuit comprises a speed control circuit.

54. The electric motor of claim 53 wherein the sequencing circuit comprises a power clock and wherein the speed control circuit comprises means for varying the frequency of the pulses emitted from the sequencing circuit power clock.

55. The electric motor of claim 53 wherein the at least one nonmaximum power mode comprises a low power mode, a medium power mode, and a high power mode.

56. The electric motor of claim 55 herein the power selector comprises a four pole switch comprising a terminal designated for each of the power modes.

57. The electric motor of claim 55 further comprising a direction control circuit adapted to alternate the direction of the sequential activation of the electromagnet units in each set between a forward direction and a reverse direction.

58. The electric motor of claim 57 wherein the direction control circuit comprises a double throw, double pole switch adapted to reverse the order in which the

sequencing circuit activates the plurality of electromagnet units in each of the sets of electromagnet units.

59. The electric motor of claim 46 wherein the plurality of electromagnet groups comprises four groups, wherein each group comprises six electromagnet sets, and wherein each set comprises four electromagnet units, and wherein each unit comprises a pair of double wound coils.

60. The electric motor of claim 46 wherein the plurality of groups of electromagnet sets comprises four groups, wherein each group comprises two electromagnet sets, and wherein each set comprises four electromagnet units, and wherein each unit comprises a pair of double wound coils.

61. The electric motor of claim 46 further comprising a direction control circuit adapted to alternate the direction of the sequential activation of the electromagnet units between a forward direction and a reverse direction.

62. The electric motor of claim 61 further comprising a speed control circuit.

63. A vehicle comprising the electric motor of claim 62 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

64. The electric motor of claim 46 wherein the sequencing circuit comprises:

a power clock connectable to an energy source and adapted to produce energy pulses;

a counter adapted to receive the energy pulses from the power clock and to produce sequential outputs corresponding to a selected one of the electromagnet units in each electromagnet set;

a matrix of OR gates adapted to receive the sequential outputs of the counter and to sustain the pulse from each sequential output for the duration of two clock pulses; and

a time delay circuit adapted to momentarily deactivate each electromagnet unit when it is directly opposite a permanent magnet.

65. The electric motor of claim 64 wherein the power clock in the sequencing circuit is a variable power clock and wherein the electric motor further comprises a speed control circuit comprising means for varying the frequency of the pulses in the variable power clock.

66. A vehicle comprising the electric motor of claim 65 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

67. The electric motor of claim 65 wherein means for varying the frequency of the pulses in the variable power clock comprises a variable resistor.

68. The electric motor of claim 46 wherein the power selector is adapted to produce a power mode output and wherein the cycling circuit comprises:

a power clock connectable to an energy source and adapted to produce energy pulses;

a counter adapted to receive the energy pulses from the fixed power clock and in response thereto to produce sequential on and off output signals corresponding each electromagnet group; and

a matrix of AND gates adapted to integrate the power mode output with the on and off output signals from the counter to produce a cycling output for each electromagnet group.

69. A vehicle comprising the electric motor of claim 68 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

70. The electric motor of claim 68 wherein the power clock is a fixed power clock.

71. The electric motor of claim 68 wherein integration circuit comprises a matrix of AND gates adapted to receive the cycling outputs of the cycling circuit and the sequencing outputs and to produce in response thereto a coil control output adapted to control the activation of all the electromagnet units.

72. The electric motor of claim 46 further comprising an energy source.

73. The electric motor of claim 46 wherein the energy source comprises a battery.

74. The electric motor of claim 72 wherein the energy source comprises a plurality of batteries including a battery to supply the drive circuit and a battery for each electromagnet unit.

75. The electric motor of claim 72 wherein the energy source comprises a fuel cell.

76. The electric motor of claim 72 wherein the energy source comprises a plurality of fuel cells including a fuel cell to supply the drive circuit and a fuel cell for each electromagnet unit.

77. The electric motor of claim 46 wherein the support comprises a stator and wherein the moving member comprises a rotor.

78. The electric motor of claim 77 further comprising a frame and wherein the stator is fixed to the frame and the rotor is rotatably supported on the frame.

79. A vehicle comprising the electric motor of claim 78 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

80. The electric motor of claim 78 wherein the permanent magnets on the rotor are supported radially further from the axis of rotation of the rotor than are the electromagnet units on the stator.

81. The electric motor of claim 46 wherein the drive circuit comprises a coil operating circuit for each coil in each electromagnet unit.

82. The electric motor of claim 81 wherein each of the coil operating circuits comprises a MOSFET having an input and first and second outputs, wherein the input is connected to the coil's control output from the integration circuit, wherein the first output is connected to ground, wherein the second output is connected to the first terminal of the coil, and wherein the second terminal of the coil is connectable to an energy source.

83. A vehicle comprising the electric motor of claim 82 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

84. The electric motor of claim 82 wherein each of the electromagnet units comprises a pair of coils double wound on the same core.

85. The electric motor of claim 82 wherein the energy source is a battery.

86. The electric motor of claim 82 wherein the energy source is a fuel cell.

87. The electric motor of claim 81 wherein the coil control outputs of the integration circuit comprise electrical pulses, and wherein the first terminal of each of the coils in a electromagnet unit is connectable to a first energy source and the second terminal is connected to ground, and wherein each of the coil operating circuits comprises:

a leading edge detector having an input and an output, the input connected to the coil control output from the integration circuit;

an SCR connected in series between the first energy source and first terminal of the coil and wherein the gate of the SCR is connected to the output of the leading edge detector;

a trailing edge detector having an input and an output, the input connected to the coil control output from the integration circuit; and

a transistor having a base connected to the output of the trailing edge detector, having a collector connectable to a second energy source, and having an emitter connected to the output of the SCR; and

wherein the first and second energy sources are connectable in series; and

wherein upon detection by the leading edge detector of the leading edge of the pulse from the integration circuit the leading edge detector turns on the SCR energizing the coil, and so that upon detection by the trailing edge detector of the trailing edge of the pulse the

trailing edge detector energizes the transistor which turns off the SCR thereby de-energizing the coil.

88. A vehicle comprising the electric motor of claim 87 and further comprising a chassis, and wherein the moving member is movingly supported on the chassis and the support member is fixed to the chassis whereby operation of the electric motor will motivate the vehicle.

89. The electric motor of claim 87 wherein the first and second energy sources are batteries.

90. The electric motor of claim 87 wherein the first and second energy sources are fuel cells.

91. A circuit for controlling electrical current supplied to a load from a first energy source having positive and negative terminals, the circuit usable with a pulsed signal source and a second energy source having positive and negative terminals, wherein the positive terminal of the first energy source is connected to the negative terminal of the second energy source, and wherein the load has an input and an output, the output connected to the negative terminal of the first energy source, the circuit comprising:

an SCR having an anode, a cathode and a gate, the anode connectable to the positive terminal of the first energy source and the cathode connectable to the input of the load;

a leading edge detector having an input and an output, the input connectable to the pulsed signal source, and the output connected to the gate of the SCR;

a transistor having a base, and emitter and a collector, the collector connected to the positive terminal of the second energy source, and the emitter connectable to the output of the SCR;

a trailing edge detector having an input and an output, the input connectable to the control signal source and the output connected to the base of the transistor; and

wherein upon detection by the leading edge detector of the leading edge of the pulsed signal the leading edge detector turns on the SCR energizing the load, and so that upon detection by the trailing edge detector of the trailing edge of the pulsed signal the trailing edge

detector energizes the transistor which turns off the SCR thereby de-energizing the load.

92. The circuit of claim 91 wherein the first and second power sources are batteries.

93. The circuit of claim 91 wherein the first and second power sources are fuel cells.

94. The circuit of claim 91 wherein the load is an electromagnet.